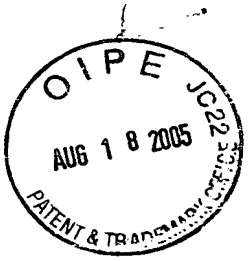

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PATENT
04091-P0001A WWW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	Peter Bernard Ketley
Application No. 10/706,732	Filing Date: November 12, 2003
Title of Application:	Detection and Identification of Vehicles with Excess Particulates in Exhaust Gases
Confirmation No. 7244	Art Unit: 2856
Examiner	Robert R. Raevis

Commissioner for Patents
Post Office Box 1450
Alexandria, VA 22313-1450

Submission of Priority Document

Dear Sir:

Applicant hereby submits a certified copy of the priority document, Australian Application No. 2002952605, to perfect Applicant's claim of priority.

Respectfully submitted,

Wesley W. Whitmyer, Jr., Registration No. 33,558
Attorney for Applicant
ST.ONGE STEWARD JOHNSTON & REENS LLC
986 Bedford Street
Stamford, CT 06905-5619
203 324-6155

Mailing Certificate: I hereby certify that this correspondence is today being deposited with the U.S. Postal Service as *First Class Mail* in an envelope addressed to: Commissioner for Patents and Trademarks; Post Office Box 1450; Alexandria, VA 22313-1450.

August 16, 2005

Gregory D. Venuto

Patent Office
Canberra

I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2002952605 for a patent by ALSTOM TRANSPORT AUSTRALIA as filed on 12 November 2002.

I further certify that the name of the applicant has been amended to ALSTOM AUSTRALIA LIMITED pursuant to the provisions of Section 104 of the Patents Act 1990.

WITNESS my hand this
Twelfth day of November 2003

JANENE PEISKER
TEAM LEADER EXAMINATION
SUPPORT AND SALES

CERTIFIED COPY OF
PRIORITY DOCUMENT

AUSTRALIA

PATENTS ACT 1990

PROVISIONAL SPECIFICATION

FOR THE INVENTION ENTITLED:-

"Detection and Identification of Vehicles with Excess Particulates in Exhaust Gas"

The invention is described in the following statement:-

FIELD OF THE INVENTION

The present invention relates to the detection of vehicles exceeding a predetermined level of particulate exhaust emissions.

The invention has been developed primarily for detecting and identifying heavy vehicles having excess particulates in their exhaust gases and will be discussed hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

BACKGROUND OF THE INVENTION

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

Gaseous and particulate emissions, for example, sulphur dioxides, nitrogen oxides, metals, carbon dioxide, and other volatile organic compounds, create air quality concerns due to their potential impact on environmental quality, human health and well-being. As a result, there has been increasing importance placed on monitoring, as well as reducing, such emission levels. Within the transport sector, difficulties have been encountered in policing exhaust gas emissions generated by vehicles.

One area where gas emission levels are of particular concern is in tunnels. In such an enclosed environment, it is extremely important to monitor and control excessive exhaust gas levels. Ventilation systems are, at present, the main means of controlling gas emission levels in tunnel environments. This system however removes the focus from those responsible for creating high gas levels in tunnel environments, something which the present invention intends to correct by way of detecting and

identifying those vehicles which are emitting particulates over and above those approved by the relevant Statutory Authority.

Recent figures have shown that those responsible for excess particulate emissions, the "gross polluters", are primarily heavy vehicles. Indeed, the figures suggest that about 10% of heavy vehicles contribute to as much as 80% of the smoky pollution found in tunnels. It therefore follows that these heavy vehicles with high particulate emissions pose a threat to the environment and general air quality. To protect tunnel atmospheres there has been a move to deter these gross polluters from entering tunnels.

Regimes currently in place for monitoring vehicles with unacceptable levels of particulate emissions often rely on trained observers monitoring vehicles over a statutorily imposed time period. Potentially infringing vehicles are pinpointed by these observers and picked up for further assessment and measurement. It will be appreciated that this technique is extremely subjective and may result in very few prosecutions.

Attempts have been made to provide more reliable systems for detecting smoky vehicles. For example, remote vehicle emission sensors have been used to detect gross polluters in traffic streams. These systems are based on the absorption of an invisible infrared laser beam by polluting gases in exhaust plumes. Each gas absorbs the laser light at characteristic wavelengths thus allowing detection of the pollutant gas. A digital image of the offending vehicle is recorded after each measurement. Coupled to a number plate reader and a vehicle type classifier, these systems can identify polluter travel patterns, improve enforcement actions and of course, result in a cleaner environment.

However, the reliability of the above systems is questionable for a number of reasons, including the considerable variation in time that exhaust may take to reach the

smoke detector/sensor. That is, the lag in detection time can result in the infringing vehicle being out of camera range by the time the camera is activated.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved form of emission detection.

According to a first aspect, the present invention provides a method for identifying a moving vehicle exceeding a predetermined level of particulate emissions, the method including the steps of:

detecting the particulate emissions of the vehicle at a first detection station;

detecting the particulate emissions of the vehicle at a second detection station downstream of the first station;

recording information identifying the vehicle if the detected emission of the vehicle at either station exceeds the predetermined level; and

comparing the recorded information from both stations and identifying the vehicle if its identity appears in the recorded information for both stations.

According to a second aspect, the present invention provides an apparatus for identifying a moving vehicle exceeding a predetermined level of particulate emissions, the apparatus including:

means for detecting the particulate emissions of the vehicle at a first detection station;

means for detecting the particulate emissions of the vehicle at a second detection station downstream of the first station;

means for recording information identifying the vehicle if the detected emission of the vehicle at either station exceeds the predetermined level;

means for comparing the recorded information from both stations; and

means for identifying the vehicle if its identity appears in the recorded information for both stations.

comprising: a first gas detection system for detecting emission from a vehicle as it transits a first transit point; an image triggering means located at a second transit point; a first imaging means interconnected to the triggering means for imaging vehicles as they transit the second transit point; and a processing means interconnected to the first particulate detection means and the first imaging means for locating identification parameters associated with the imaged vehicles when the first particulate detection system detects an emission exceeding a predetermined level.

BRIEF DESCRIPTON OF THE DRAWINGS

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a schematic plan view illustrating the method and apparatus of the invention as applied to vehicles moving to the left in the direction indicated by the arrow.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, the method of the preferred embodiment is shown as applied to a roadway 1, where the vehicle 2 proceeds in a direction from right to left. Two detection stations 3 and 4 are provided for detecting the particulate emissions emitted from vehicle 2. As shown in the Fig., the second detection station 4 is 120 metres downstream of the first detection station 3. Each of the detection stations includes a means e.g. 5 for detecting levels of particulate emissions. More specifically, predetermined levels of particulate emissions are detected by the triggering of a smoke detector beam. The detection stations 3 and 4 also include a means 6 for recording information identifying the vehicle if the detected gaseous emissions exceed the predetermined level. More specifically, the triggering of the smoke detector opens an

output possibility from an interruptible light beam. Upon the vehicle passing through the light beam an image capturing device 7 is activated.

Turning to Fig. 2 where there is shown a side view of a smoky vehicle 2 traversing a roadway 1, a number of assumptions can be made about the vehicle's transit. Assuming a smoky vehicle is travelling at a maximum speed of 108 kph (30m/sec) with a stack 10 at a height of at least 3.2 metres, an exhaust 20 with vertical velocity of 10m/sec and with the smoke detector 5 at a height of 5.2 metres, then a smoky vehicle will travel 6 metres past the detector 5 before the exhaust reaches the level of the smoke detector 5. A time of 100 milliseconds is allowed for the detector to respond during which the vehicle travels a further 3 metres, giving a total of 9 metres. Assuming that the stack 10 is placed a maximum 4 metres behind the first part 21 of the vehicle which is 2.6 metres or higher, the light beam 6 should be placed at least 13 metres after the smoke detector as shown in the Fig. 2.

Returning to Fig. 1, if excessive gaseous emissions are recorded for vehicle 2 at the first detection station, a first image of the registration number is taken by camera 7. A similar process is repeated at the station 4. Should vehicle 2 still be emitting excessive particulates by the time it reaches the second detection station a second image will be produced. With the aid of OCR recognition a match can be made and the images at both stations are stored and a wide angled scene photograph is taken and stored for later evaluation.

If there are no other vehicles taller than 2.6 metres in the "scene" photograph, then it can be reasonably assumed that vehicle 2 has produced excessive smoke for the last 120 metres, somewhere between 4 seconds to 12 seconds.

Alternatively, vehicle 2 may trigger the smoke detector at the first station 3 causing the interruptible light beam mode to switch to operational mode and thus

activate the camera upon the vehicle passing through the light beam. However, in this case, the vehicle stops emitting excessive gaseous emissions and thus the smoke detector at the second station is not triggered and a second photograph is not taken. Accordingly, the image taken at the first detection station may be discarded.

In a longitudinally ventilated tunnel, airflow will always be in the direction of the traffic except at the tunnel exit portal. This means that exhaust gases from a vehicle will not be blown against the direction of travel allowing the time which an exhaust plume passes a certain point after the exhaust stack to be calculated. This calculation is based on the speed of the smoky vehicle, the height of the point above the stack and the vertical velocity of the exhaust outlet.

It will be appreciated that this calculation is important for determining the distance that the vehicle has travelled by the time the exhaust plume has been detected in order that the camera may be placed at an appropriate distance from the smoke detector.

As to the details regarding the detection of particulate emissions, a wide range of suitable smoke detectors are currently on the market. Linear smoke detectors like for example, EDS linear smoke detectors model RK60 available from EDS srl - Electronic Detection Systems V. Cà-Nova Zampieri 6 - 37057 - S. G. Lupatoto Verona, are thought to be particularly suitable for carrying out the preferred embodiment. These smoke detectors are made of a number of infrared beam optoelectronic projectors: a transmitter and a receiver. The infrared beam emitted by the transmitter is directed to the receiver that converts the incident radiation in an electric signal. In operation, smoke travels up and intercepts the infrared beam causing a change in the electrical state, voltage, of the receiver which is measured with respect to time. High rate changes indicate the introduction of a new high level of smoke..

Camera activation

As discussed above, there is considerable variation in the time that exhaust emissions take to reach smoke detectors. It is therefore not a reliable method of activating a camera to capture a vehicles registration number plate. The preferred embodiment provides an alternative to this mode of detection.

The method of the preferred embodiment is based on an interaction between the smoke detector used to detect a smoky vehicle and a camera system used to capture an image of the offending vehicle. This is preferably achieved with the use of a light beam connected to a camera system. In operation therefore a vehicle passes through and breaks the light beam which instantly operates a camera. The light beam is placed at a suitable height so that only vehicles of interest, in this case heavy vehicles/trucks, have a height sufficient to pass through the beam. Vehicles like cars, bikes, vans and four wheel drives are not being targeted by the present invention and will not activate the camera since they will not break the light beam.

Logically, the camera need only be triggered if the vehicle is a smoky vehicle. Accordingly, the output of the interrupted light beam only triggers the camera if the smoke detector has also been triggered immediately prior.

A suitable camera system for carrying out the method of the preferred embodiment is for example the Redflex system available from Redflex Traffic Systems.

Although the invention has been described with reference to a specific example, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

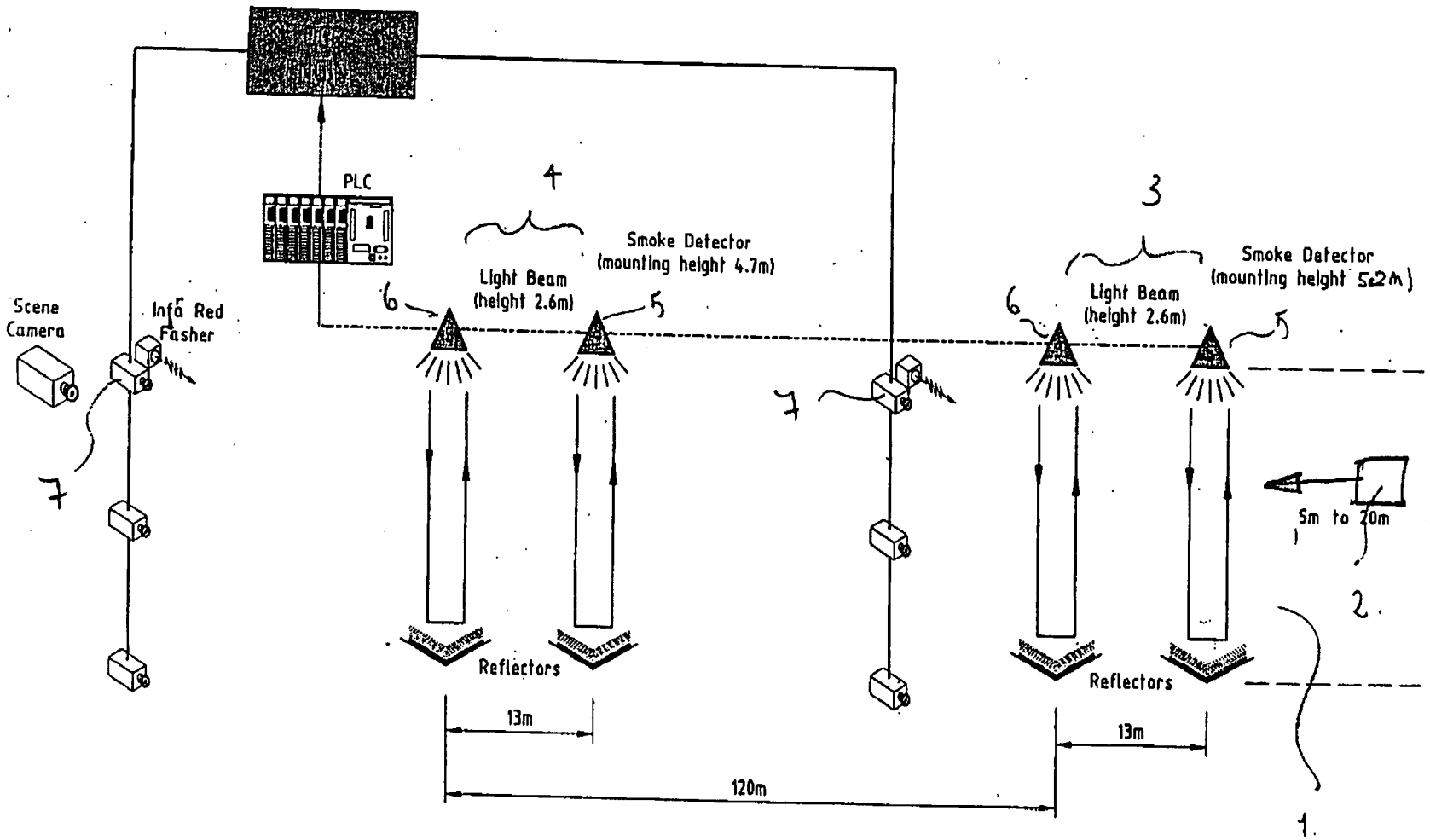
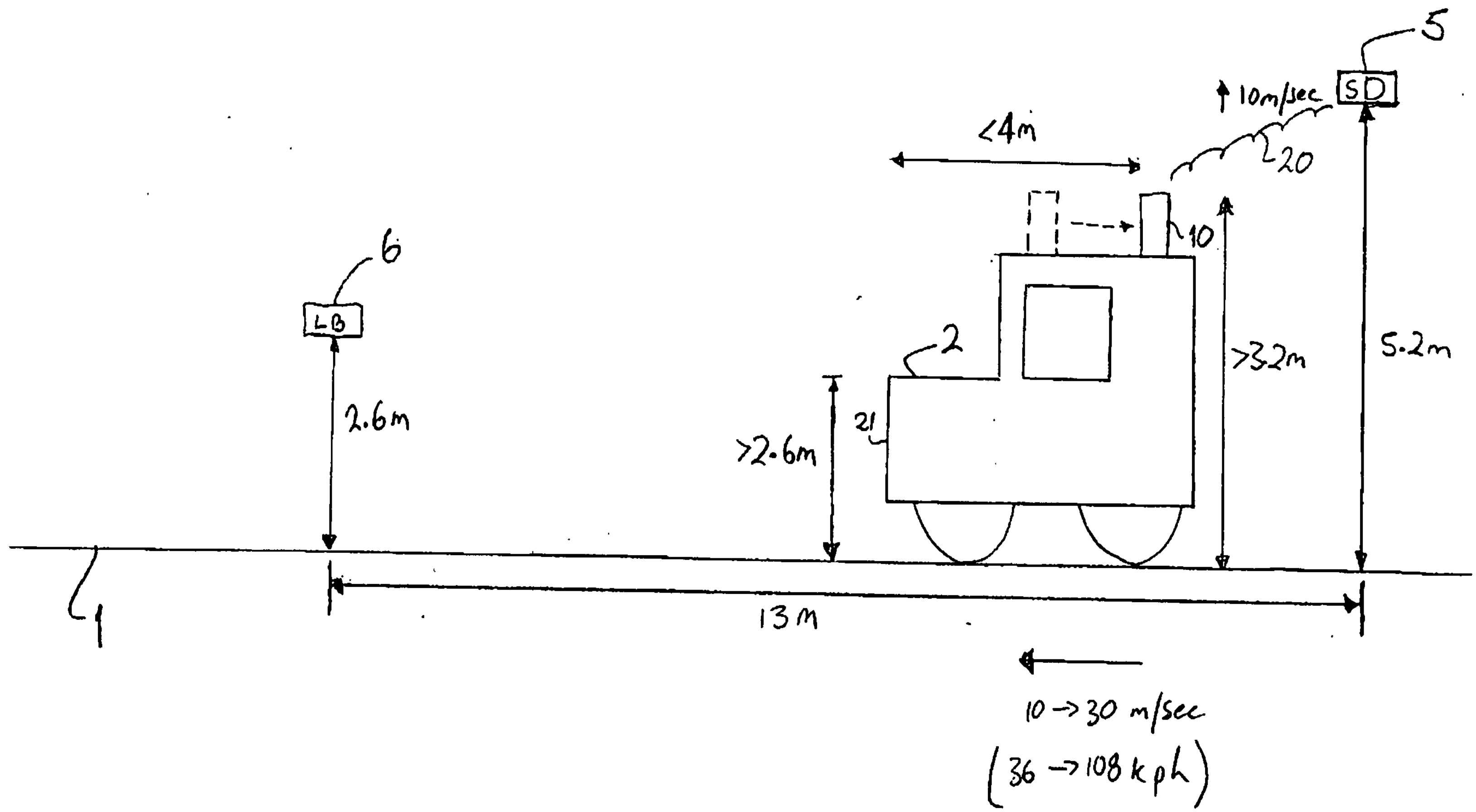

PLC
4
Smoke Detector
(mounting height 4.7m)
Light Beam
(height 2.6m)
6
5
3
Smoke Detector
(mounting height 5.2m)
Light Beam
(height 2.6m)
Scene
Camera
Infa Red
Flasher
7
Reflectors
13m
120m
5m to 20m
2
1

FIG. 1



5
SD
↑ 10m/sec
20
<4m
10
6
LB
2
2.6m
>2.6m
21
>3.2m
5.2m
1
13m
10 → 30 m/sec
(36 → 108 kph)